Further Evidence on the Impact of Economic News on Interest Rates*

Dominique Guégan[1]

Florian Ielpo[2]

Abstract

We investigate the shape of the term structure reaction of the US swap rates to announcements using several linear and non-linear time series models. We document the non-linearity of the market reaction to macroeconomic news. First, we find that the introduction of non linear models leads to the finding of a significant number of macroeconomic figures that actually produce an effect over the yield curve. Second, we noticed at least four types of patterns in the term structure reaction of interest rates across maturities, including the hump-shaped one that is generally considered. Third, we propose a first interpretation and classification of these different shapes. Fourth we find that the existence of outliers in interest rates leads to an underestimation of the reaction of interest rates to announcements, explaining the different results obtained between high-frequency and daily datasets.

Keywords: Macroeconomic Announcements, Interest Rates Dynamic, Outliers, Reaction Function, Principal Component Analysis.
JEL classification: G14

---

* The authors are thankful to Oscar Bernal, Roberto Reno, Roch Heraud, to the seminar participants of the Journée d'Econometrie : développements récents de l'économétrie financière (Nanterre, France, 2006) and of the second Italian Congress of Econometrics and Empirical Economics (Rimini, Italy, 2007) for very helpful comments. We also thank two anonymous referees for their comments and remarks. All errors remain ours.

[1] Centre d'Economie de la Sorbonne -- CERMSEM, UMR 8174, Maison des Sciences Economiques, 106 bd de l'Hôpital, 75013 PARIS. Email: dguegan@univ-paris1.fr. Tel: +33 1 40 07 82 98.

[2] Pictet & Cie Asset Management, Route des Acacias 60, CH-1211 Genève 73. E-mail: florian.ielpo@ensae.org.

1 - Introduction

Measuring the impact of news on financial markets is essential to document the key features any asset pricing model should withstand. What is more, due to the tight links between economics and asset prices, questions of this kind are also essential to macro-economist. For example, when the US GDP figure is released, the deviation of the realized figure from the market consensus leads to a very fast revision of the market's beliefs. This revision results most of the time in a change in what is considered as the fair value of asset prices. This kind of rationale is especially true when dealing with fixed income securities.

One of the versions of the expectation hypothesis[3] states that the whole yield curve can be seen as an expectation of the upcoming expected short rates. It seems natural to combine the Taylor (1993) rule approach to the short rate modelling with this expectation hypothesis. In this perspective, it is relatively easy to understand how, through no arbitrage arguments, it is possible to relate and explain the behaviour of the yield curve, based on a few macroeconomic figures. Works of this kind can be found in the recent macrofinance literature. For example And and Piazzesi (2003) propose to describe the economy with a few Vector AutoRegressive (VAR) related macroeconomic factors. They show how these factors under no arbitrage opportunities are able to price zero coupon yields.

This stream of models aim at capturing the dynamic behaviour of the level of interest rates. Unfortunately, these models cannot handle the other way around macroeconomic figures: when released, these figures are known to produce movements in interest rates markets. If several market participants bet on the future stance of the yield curve -- using Futures or swap rates -- a great number of them also take bets on the daily -- if not intra-day -- impact of news on the yield curve. The rationale behind these trading strategies stems from the fact that the biggest moves in bond markets are actually produced by the disclosure of economic information.

Roughly speaking, most of the macroeconomic announcements are either released on a weekly, monthly or quarterly basis. Before the announcement, pools of economists are interviewed and deliver their forecast

[3] On the expectation hypothesis, see the extensive discussion in Campbell and Shiller (1991) and in Jarrow (2002).

for the upcoming figure. For Bloomberg users, what is considered as the market's forecast is the median of the pooled forecasts. This figure is then used to analyze the actual figure when released: the market analysis of macroeconomic announcements is often performed by comparison with the economist forecast. The market reaction to news is then a function of the spread between the forecast and the disclosed figure.

The dedicated academic literature empirically demonstrated several, now well-known, results: first, a lot of macroeconomic news produce an impact on the bond market; second, there exists a term structure effect of macroeconomic news. The reality is, of course, much more complex: the term structure effect of news on the bond market is expected to be economic cycle-dependent. The intuition beyond this is simply that the macroeconomic figures and the market's reaction to them is based on the Central Bankers' speech on the upcoming economic threats. When the business cycle is going down, activity and employment figures are closely monitored. On the contrary, when the economy is roaring, the attention is focused on inflation and expected inflation indicators.

Needless to say, the impact of news on financial markets has not only been documented on the bond market side: the equity market is also known to react to many announcements. There is actually a huge literature investigating the effect of information disclosure on either stock indexes or individual components of these indexes. On the reaction of these markets to news, see for example Lardic and Mignon (2003) and the references presented in this article. Even if the methodologies used for this stream of literature are related to what we propose here, bond markets are way more dependent on macroeconomic figures than stocks. Thus, the news that are investigated here strongly differ from stock-market related news: for example, the consensus forecast regarding the upcoming macro-figures makes the analysis of the surprises easier. Finally, there are a lot of news stemming for example from Central Bankers' speeches, but these are not quantitative and thus very hard to handle. On this point see Brière (2006). This is however beyond the scope of this article.

Thus, the term structure impact of news is not always the same: it clearly depends on the type of news that is investigated. Brière and Ielpo (2008) provides elements in this direction using the Euro swap rates: this dataset is relatively new and thus small. With this kind of information set, it is difficult to move one step forward and answer the question: for a single figure, is the shape of the term structure impact changing, depending on economic conditions? Following what is presented in Dufrénot et al. (2004), we show that there exists a strong dependence on the business cycle, since the monetary stance itself -- and thus the yield curve -- depends on the business cycle. In this article, we tackle this issue using an American dataset, whose depth is larger than the European one.

There has been a flourishing literature related to the impact of US news on interest rates that is surveyed in Fleming and Remolona (1997). First, early articles studied the impact of a selected number of macroeconomic figures on selected points of the yield curve. For example, Grossman (1981) and Urich and Watchel (1981) chose to focus on money supply surprises for selected maturities of the yield curve. Hardouvelis (1988) and Edison (1996) investigated the impact of employment news along with Consumer Price Index (CPI) and Producer Price Index (PPI) in a similar fashion. Second, while the former studies used daily datasets, the most recent ones made the most of the newly available high-frequency data, assuming that the measurement of the interest rates' reaction to surprises on a narrower window of time was bound to lead to more precise results. The results obtained pointed toward important facts: where studies achieved using daily data only found a few market mover figures, these studies (see for instance Balduzzi et al. (2001), Fleming and Remolona (1997) and Fleming and Remolona (2001)) concluded with the fact that as much as 70 releases actually produce moves within the U.S. bond markets. These three articles can also be regarded as dealing with informational concerns, since they investigate the actual time period necessary for financial markets to incorporate the news in asset prices. Finally, recent papers focused on the complete term structure response to macroeconomic news. Using an intraday dataset, Fleming and Remolona (2001) revealed hump shaped term structure effects.

Here, we propose different nested time series models to assess the shape of the term structure reaction to macroeconomic announcements. More, we allow this term impact to depend on various state variables: this way, we intend to capture the changes in the shapes depending on the economic or monetary cycles. The main estimation results unfold as follow. First, we find that there exist several types of surprises that actually affect the bond market, surprisingly matching the first four factors found when performing a principal component analysis over the daily changes in swap rates. Second, the ranking of market mover figures strongly depend upon the market perception of the economic cycle, measured by publicly available indicators, and upon the monetary policy stance, measured by the Fed's target rate. Finally, we show that the use of a threshold model when estimating the market response to macroeconomic news leads to the elimination of outliers within the dataset, yielding different - and often more statistically different from zero - estimates of the market response to selected figures. The exclusion of these outliers brings about interest rates' reaction functions that are generally upper than the classical ones and more concave.

The remaining of this section is organized as follow. In Section 2, we present the methodology to estimate the term structure response to macroeconomic news. In section 3, we review the empirical results obtained, underlining the importance of taking into account the business and monetary cycles. In section 4, we present a detailed analysis regarding selected figures for which we present a strong underestimation problem induced by the usual linear model used in the literature. Section 5 concludes.

2 - Assessing the shape of the market reaction function

In this Section, we detail both the dataset and the time series models used to analyze the effect of the announcements on the US swap rate across maturities. The dataset used along the paper and its preliminary treatment is closed to the one used in the main articles investigating the bond market reaction to macroeconomic news, such as Balduzzi et al. (2001) and Fleming and Remolona (2001). The main novelty of this paper being the methodology, we present it in a detailed fashion so as to highlight our contributions.

2.1 The dataset

Along this paper we use two types of data. On the one hand, we use the daily changes in the US swap rates from June, 24th of 1996 until March, 1st 2006, for the following maturities: 1- to 10-year, 15-year, 20-year and 30-year swap rates. By daily changes, we mean the difference between two following daily closing rates. Let $\Delta r_t(\tau)$ be this change in the closing swap rate $r_t(\tau)$ for a maturity equal to τ, on a date t. Then, we have:

$$\Delta r_t(\tau) = r_t(\tau) - r_{t-1}(\tau) \qquad (1)$$

with a time unit equal to one day. One main advantage to use swap rates is that they are generic rates: these rates have a constant time to maturity over the whole sample and thus do not theoretically depend on time. Using such rates means that we do not have to deal with the reduction of the time to maturity. We also had to estimate some missing rates, which was done using the cubic splines method, like in Bomfim (2003)[4].

The US swap rates dataset has been extracted from the Bloomberg database. The Bloomberg closing swap rates are gathered from different brokers and financial institutions at the closing of each US bond market trading day. During a trading day, the moments the intraday database is updated is rather random and this randomness extents to the maturities that are updated. On the contrary, for the closing swap rates, the time of the update is rather homogeneous. This is why we propose to use a daily dataset made of these closing swap rates.

From the Bloomberg database, we also extracted the US economic calendar across the dates already mentioned for the swap rates. This calendar contains every economic announcement linked to the US economy which are supposed to be monitored by financial market participants[5]. Several of these figures are well known by economists, such as the Non Farm Payroll figure, which is the number of jobs created on a one month period. These figures are issued regularly by office statistics such as the Bureau of Labour Statistics. For example, the Non Farm Payroll figure is issued every first Friday of a month and is usually followed by large moves in the bond market. Other figures are no so well known, and one of the purposes of this paper is to cast some light on the effect of these indicators on the term structure of the US swap rates.

---

[4] This is a classic method, discussed in classical textbooks, e.g. Martellini et al. (2003). Note that the results obtained hereafter remain globally unchanged when using a simple interpolation method for missing observations. This may due to the fact that the number of missing observations is below 1% of the whole sample.

[5] This is however not the only information considered by the US bond market. However, since we need an important sample length for our estimation purposes, we discarded the use of European and Chinese news that would oblige us to use a shorter sample.

Table 1: List of the macroeconomic announcements studied in this paper. These announcements are monthly ones, except for: Weekly Jobless Claims (weekly figure), Personal Consumption (quarterly figure), Capacity Utilization Rate (quarterly figure) and GDP (quarterly figure).

Growth	**Conjonctural Indicators**	**Real estate**
Industrial New orders	ISM manuf	Construction Spending
Wholesale Inventory	Philifed Index	Housing Start
Industrial Production	Conf. Board Consumer Conf.	Existing Home Sales
GDP	Chicago PMI	New Home Sales
Trade Balance	Non Manuf. ISM	Building Permits
Capacity Utilization Rate	Consumer Conf. Michigan	NAHB Housing Market Index
Durable Good Orders	Empire Manufacturing	Construction Spending
Labor Market	**Consumption**	**Inflation**
Unemployment Rate	Household Consumption	Consumer Price Index
Jobless Claims	Personal Income	Producer Price Index
Non Farm Payroll	Consumer Credit	Import Price Index
Employment Cost Index	Retail Sales	
Wages	Personal Consumption (Q)	
Hourly Average Wages		
Weekly Working Hours		
Weekly Jobless Claims		
Indice Help Wanted		

We discarded several series from the Bloomberg database. Table 1 presents the selected figures used during the estimation process. We eliminated these series for different reasons. First, some of the figures got their names changed over the studied period. In this case, we simply changed the old names into the newer ones so as to avoid having a single figure known under different names. This was the case for the Michigan Consumer Confidence that was reported under several names in the Bloomberg Calendar. Second, some of these figures were ill reported and included a lot of missing values. Finally, some of these figures ceased to be released during the studied period, such as the M3 aggregate and we chose not to include them, to make this study of interest both for academics and practitioners.

Most of the announcements studied are monthly (see table 1). The series were treated by the Bloomberg calendar the way bond market participants do. For example, the surprise in the Consumer Price Index (CPI hereafter) is a surprise in the month-over-month figure. A month-over-month (m-o-m hereafter) figure is simply the percentage of growth of the index over the month. With an index denoted I_t for the month t, the m-o-m figure will be equal to $\frac{I_t}{I_{t-1}} - 1$, with a time unit equal to one month. The same kind of transformation applies for most of the figures but the sentiment survey such as Purchasing Manager Index (PMI) or Michigan Consumer Confidence. These survey figures are often presented using the value of their index. This is a rather technical knowledge many books are devoted to. Anyone interested in these ways of processing data can get in depth analysis in such books (see e.g. Baumohl (2005)).

In our methodology, we used the first estimates of the macroeconomic news. Most of the macroeconomic figures released in the US are initially preliminary estimates. On the next announcement for the same figure, a revised estimate of the preceding figure is released. Most of the macroeconomic datasets used in empirical papers are made of the revised estimates of every macroeconomic figures. Recently, Orphanides (2001), Bernanke and Boivin (2001) and Kishor and Koenig (2005), among others, took this data revision problem into account, highlighting the importance of this phenomenon on macroeconomic empirical models. For our purposes, the use of the first estimate is of tremendous importance: the first announcement is the one bond market participants had to face with and eventually reacted to.

What is more, the Bloomberg calendar also contains the Bloomberg forecasts regarding each of these figures. Bloomberg forecasts are formed using the 50% empirical quantile of the distribution of a survey made of the forecasts of several bank economists, regarding a precise figure. The use of the median as a measure of the expectations makes the forecast robust to the influence of badly intentioned economists that would want to shift the forecast in order to make the most of it. What is more, this forecast is extensively used by market participants. For each figure that is predicted by Bloomberg's collection of economists' forecasts, the median is regularly updated until every economist answers the survey, which can take up to two weeks. We retained the last median computed by the Bloomberg services, so as to match both the practitioners and academic ways of doing things. Some of the eliminated series were discarded because there was no available forecast.

2.2 The econometric specification

In this section, we skip to the presentation of the time series models used along the paper. The first model is the classical linear model presented earlier. Let $S_{t,i}$ denote the surprise at time t in the figures indexed by i as follows:

$$S_{t,i} = \frac{R_{t,i} - F_{t,i}}{\sigma_{S_i}} \qquad (2)$$

where **Error! Objects cannot be created from editing field codes.** is the market consensus about the upcoming figures **Error! Objects cannot be created from editing field codes.** for **Error! Objects cannot be created from editing field codes.**, the date of release; $R_{t,i}$ is the real announcement (the first estimate) at time **Error! Objects cannot be created from editing field codes.** of the same figure **Error! Objects cannot be created from editing field codes.**. To make the surprises comparable, surprises are scaled using their historical standard deviation. This way of proceeding is very common, see e.g. Edison (1996), Fleming and Remolona (1997, 2001) and Balduzzi et al. (2001). We used the Bloomberg forecasts as a measure of the market consensus for a given figure at a given date. Thus **Error! Objects cannot be created from editing field codes.** will be proxyed by the last forecast in the Bloomberg database for each announcement.

Building a time series model to relate the macroeconomic surprises to the changes in the interest rates of maturity τ requires some preliminary considerations, and especially for the dataset building. Even though there seems to be some regularity in the time of arrival of these surprises, they are irregularly spaced in time, preventing the building of a single global model to relate any surprises to the daily changes in rates. For example, the Non Farm Payroll are scheduled to be released on the first Friday of each month: even though this seems to be a regular release pace, it still leads to data that are irregularly spaced in time, in so far as the number of days from the first Friday of a month to the next one is not always the same. What is more, estimating a global model as asserted before would involve the use of 40 exogenous variables which may threaten the robustness of the results. Moreover, the sampling frequency of the exogenous variables can differ: our work involves both quarterly, monthly and weekly news. Finally, the endogenous variable (namely $r_t(\tau)$) depends on the maturity τ of the swap rates. For several maturities, the model to built should be a generalized linear model (a model that encompasses several dependent variables in the meantime), which thus requires to be estimated using the (Quasi) Generalized Least Squares. To solve these difficulties, we built one model for each each surprise and each maturity, in a similar fashion to the \ *Seemingly Unrelated Regression Models*. This has an obvious consequence over the chosen notations: the subscripts must display the dependency on time, maturity and macroeconomic surprise.

Now, let us denote $\Delta r_{t,i}(\tau)$ the daily change in swap rate of maturity τ on the date t of the release of the figure indexes by $i = \{1,2,...,I\}$, where I is the total number of surprises. The couple (t,i) is somewhat a calendar coordinate in the global dataset. The linear model (model 1 hereafter) assumes for given (fixed) $i = \{1,2,...,I\}$ and $\tau = \{\tau_1, \tau_2, ..., \tau_m\}$ that:

$$\Delta r_{t,i}(\tau) = \beta_{i,\tau} + \alpha_{i,\tau} S_{t,i} + \varepsilon_{t,i,\tau}, \qquad (3)$$

where $\alpha_{i,\tau}$ and $\beta_{i,\tau}$ are real-valued parameters. $\varepsilon_{t,i,\tau}$ is a Gaussian white noise with standard deviation $\sigma_{i,\tau}$, conditionally upon $S_{t,i}$. In the remaining of the paper, we denote these conditions as conditions (2.2). This very simple model is usually augmented with the other surprises announced on the same day (t,i) :

$$\Delta r_{t,i}(\tau) = \beta_{i,\tau} + \alpha_{i,\tau} S_{t,i} + \sum_{j=1}^{J} \gamma_{i,\tau} S_{t,i}^{j} + \varepsilon_{t,i,\tau}, \qquad (4)$$

where $S_{t,i}^{j}$ are the scaled surprises j announced on the same day as surprise i. Again, we assume that $\gamma_{i,\tau}, \forall j$ is on the real line. These additional surprises are essential to ensure that the estimated $\alpha_{i,\tau}$ truly isolate the effect of the announcement that is analyzed. It is noteworthy to remark that the news time series are made of a lot observations equal to zero, for each non-announcement day. Because of this very particular structure, the correlation between news time series is generally very close to 0. Hence, there is usually no collinearity problem when estimating equation (4). What is more, the number of coincident news is not very important: see the table presented in Balduzzi et al. (2001).

In this section, we build a collection of nested time series models to capture the term structure reaction to macroeconomic news. The linear model defined by equation (3) is the first model. For the ease of the presentation, we will get rid of the part of the equation (4) that is dedicated to the announcements released on the same date as the announcement studied (that is $\sum_{j=1}^{J} \gamma_{i,\tau} S_{t,i}^{j}$), maintaining it during the estimation. What is more, for the sake of simplicity, we do not denote anymore the maturity of each change in the swap rate, skipping from $\Delta r_{t,i}(\tau)$ to $\Delta r_{t,i}$ (the same treatment also applies to the parameters of the model): we present the models for a given and fixed τ.

The immediate consequence of the model 1-like specification is:

$$\mathrm{E}\left[\Delta r_{t,i}(\tau) \middle| S_{t,i}\right] = \beta_{i,\tau} + \alpha_{i,\tau} S_{t,i}. \qquad (5)$$

This expectation has an important implication: whatever past information and the state of the economy, the conditional expectation of the rates' jump is always the same, for a given surprise, i.e. $\alpha_{i,\tau} S_{t,i}$. This is not in line with what can be observed both by practitioners and academics. We propose two nested non-linear models to account for these facts.

First, with model 1, the market reaction to a given surprise is bound to be the same for each state of the economy. The rates' response to macroeconomic announcements may depend on several factors such as the timeliness of the release - that is the order of release for a one month period -, the degree of surprise, the conditions of market uncertainty or the sign of the surprise. On these points, see Fleming and Remolona (1997) and Hans (2001). Other articles pointed toward the fact that the interest rates' response to macroeconomic announcements may also depend on a threshold variable, such as economic leading indicators or employment figures. For example, Prag (1994) shows that the impact of unemployment surprises on the bond prices may depend on the current level of unemployment. Veredas (2005) shows that the market response to surprises in macroeconomic releases strongly depends upon the momentum of the cycle: in this framework, bad news have more impact on bond prices during expansion periods than recession ones. This may be due to the importance of bad news during expansion periods to forecast a change in the business cycle. Here, we argue that the market response depends on several threshold variables, including indicators for monetary policy stance and economic agent sentiment regarding future activity.

Thus, we propose to use a threshold time series model. Given the small number of observations we have at hand[6], we will consider a two states economy, say recession/expansion states. Let us define $\left(\pi_{t,i}\right)_{i\in Z}$, an observable process that is used as a state variable to capture the conditional reaction to the surprises in the macroeconomic figure i. With this state variable, we measure the state of the economy as follow: this process has to cross a threshold value $\overline{\pi_{t,i}}$ for the economy to go through a change in state, say from expansion to recession. For each $i = \{1,2,...,I\}$, model 2 is then the following:

$$\Delta r_{t,i} = \beta_i + \alpha_{1,i} 1_{\pi_{t,i} > \overline{\pi_{t,i}}} S_{t,i} + \alpha_{2,i} 1_{\pi_{t,i} \leq \overline{\pi_{t,i}}} S_{t,i} + \varepsilon_{t,i}, \qquad (6)$$

[6] For monthly figures, we only have one announcement a month, which makes 120 observations with no missing value in the dataset. For the quarterly figures, this makes only 30 observations.

where $1_{\pi_{t,i}>\overline{\pi_{t,i}}}$ takes value 1 if $\pi_{t,i} > \overline{\pi_{t,i}}$ and 0 if not. $1_{\pi_{t,i}\leq\overline{\pi_{t,i}}}$ is defined as $1-1_{\pi_{t,i}>\overline{\pi_{t,i}}}$. $\alpha_{1,i}$ and $\alpha_{2,i}$ are again on the real line. The assumption 2.2 applies again. This model belongs to the class of the SETAR models (Self-Exciting Autoregressive models) introduced by Lim and Tong (1980) and developed in Tong (1990). The particular choice for this model is motivated by the initial purpose of this article. This kind of model is designed to compare two very different periods in the economic cycle, with a sharp transition between these periods. This is a methodological choice we made to take into account the well-known fact that during sharp economic downturn, financial agents' expectations are going through a rapid modification.

The estimation of threshold models has been discussed in Chan (1990), Hansen (1997,2000) and Tong (1990) [chapter 5], and asymptotic estimation results have been derived in it. With these models, the log-likelihood function is not continuous in the threshold parameter. Thus, the threshold cannot be estimated using standard Gradient methods. The estimation can be performed by grid search. This is a standard method in econometrics, as detailed in Greene (2000), in the chapter dedicated to numerical optimization.

The model proposed in equation (6) leads to the following conditional expectations:

$$\mathrm{E}\left[\Delta r_{t,i} \middle| S_{t,i}, \pi_{t,i} > \overline{\pi_{t,i}}\right] = \beta_{i,\tau} + \alpha_{1,i} S_{t,i}. \qquad (7)$$

$$\mathrm{E}\left[\Delta r_{t,i} \middle| S_{t,i}, \pi_{t,i} \leq \overline{\pi_{t,i}}\right] = \beta_{i,\tau} + \alpha_{2,i} S_{t,i}. \qquad (8)$$

Thus, the market reaction clearly differs, depending upon the state variable. Once again, each macroeconomic figure can be linked to a proper threshold variable $(\pi_{t,i})_{i\in Z}$, along with a proper threshold value $\overline{\pi_{t,i}}$. Now, we need to select variables to proxy this state variable. Clearly, there is no unique answer: sentiment survey (such as PMI index or Conference Board index) could be a good proxy for this variable. These sentiment survey can be considered as coincident or leading indicators of the stance of the economy and thus reflects the market sentiment better than real aggregates such as industrial indicators or GDP. Monetary policy is also known to play an important part in the psychology of the bond market. This is why we also introduced the Fed's target rate, as a measure of the monetary policy stance.

The table 2 presents the different threshold variables that we retained for the estimation of the threshold model. Note that to these variables, we add the first and second factors of a principal component analysis performed over all these variables, so as to get a global economic confidence index. This is a classical method used to build this kind of global economic stance index (see e.g. Stock and Watson (2002)). So as to avoid any data vintage problem, as presented e.g. in Kishor and Koenig (2005), we used the first estimates of every of these series: they were the ones at hand for market participants, at the time of their reactions to the announcements. In the section dedicated to the estimation results, we present the results of the choice of the threshold variable. For each surprise, we retain the threshold value that yielded the highest log-likelihood value or the lowest root mean square error. These results show the benefit from estimating each model for each macroeconomic figure and each maturities: the selected threshold variable can clearly differ depending both on the rates' maturity and the figure that is studied.

Table 2: Threshold variables used in the estimation process

Indicator...	**... as a measure of**	**Mean**	**Std. Deviation**
PMI	Future economic activity	53.02	5.26
Conf. Board	Future economic activity	112.24	21.00
Michigan	Future economic activity	96.80	8.90
Fed fund	Monetary policy stance	3.73	1.91
Fed Philadelphie	Future economic activity	9.54	13.52
Factor 1	-	87.30	14.30
Factor 2	-	-128.47	18.38

In the table presenting the results of our estimations, we refer to these threshold variables using the following notations: PMI is for PMI index, CONF is for Conference Board Consumer Confidence, MICH is for Consumer Confidence Michigan, FED is for the Fed Target Rate, PHI is for the Philifed Index and FACT1 and FACT2 refer to the first two factors of a principal component analysis performed over all these series.

Finally, we propose to test for path dependency in the dynamics of the rates. By this, we simply mean to specify a model that would link the rates' reaction during two successive announcements of the same figure. Note that most of the time, a month elapsed between two successive announcements. We propose to test whether a part of $\Delta r_{t_k,i}$ is explained by the rates' reaction at time (t_{k-1}, i), that is the bonds over- or under-reaction during the former announcement for exactly the same figure i. When model 2 provides consistent estimates of the reaction of the market to announcements, the residuals of this model can be used as a proxy to measure the rates' over or under reaction to a given announcement. Thus, a natural measure of the market absolute overreaction at time (t_{k-1}, i) is $\varepsilon_{t_{k-1},i}$. By adding this term to the model proposed in equation (6), we obtain model 3:

$$\Delta r_{t_k,i} = \beta_i + \alpha_{1,i} 1_{\pi_{t,i} > \overline{\pi_{t,i}}} S_{t,i} + \alpha_{2,i} 1_{\pi_{t,i} \leq \overline{\pi_{t,i}}} S_{t,i} + \theta_i \varepsilon_{t_{k-1},i} + \varepsilon_{t_k,i}, \quad (9)$$

where $\theta_i \in \Re$ such that $\mathrm{E}\lfloor \Delta r_{t_k,i} \rfloor < \infty$. Conditions 2.2 still apply. By the law of iterated expectations, $\mathrm{E}\lfloor \theta_i \varepsilon_{t_k,i} \rfloor = \mathrm{E}\lfloor \mathrm{E}\lfloor \theta_i \varepsilon_{t_k,i} | \pi_{t_k,i}, S_{t_k,i}, \varepsilon_{t_{k-1},i} \rfloor\rfloor = 0$. Thus, we can rewrite equation (9) with a mean reverting error process:

$$\Delta r_{t_k,i} = \beta_i + \alpha_{1,i} 1_{\pi_{t,i} > \overline{\pi_{t,i}}} S_{t,i} + \alpha_{2,i} 1_{\pi_{t,i} \leq \overline{\pi_{t,i}}} S_{t,i} - \theta_i (\mathrm{E}\lfloor \theta \varepsilon_{t_k,i} \rfloor - \varepsilon_{t_{k-1},i}) + \varepsilon_{t_k,i},$$

(10)

The interpretation of θ_i in equation (10) arises naturally. Let us distinguish three cases. If $\theta_i = 0$, this obviously means that there is no linear link between the past overreaction and the current one. Second, if $\theta_i > 0$, the bond market tends to be self exciting: when an over/undershoot occurs when releasing a figure, then there is a higher probability that the market will over/undershoot again on the next release of the same figure. On the contrary, if $\theta_i < 0$, the market responses to announcements are mean reverting (toward a mean equal to 0). In the latter case, an over/undershoot is likely to be followed by a smoother reaction on the date of the next release of the same figure. Note that from a statistical point of view, if θ_i is statistically different from 0, the estimation of model 1 is likely to be biased.

The conditional expectation of $\Delta r_{t_k,i}$ is path dependent: the rates' response will depend on their former reaction to the announcement of the same figures. Thus we have:

$$\mathrm{E}\left[\Delta r_{t,i} \middle| S_{t,i}, \pi_{t,i} > \overline{\pi_{t,i}}, \varepsilon_{t_{k-1},i}\right] = \beta_{i,\tau} + \alpha_{1,i} S_{t,i} + \theta_i \varepsilon_{t_{k-1},i} \quad (11)$$

$$\mathrm{E}\left[\Delta r_{t,i} \middle| S_{t,i}, \pi_{t,i} \leq \overline{\pi_{t,i}}, \varepsilon_{t_{k-1},i}\right] = \beta_{i,\tau} + \alpha_{2,i} S_{t,i} + \theta_i \varepsilon_{t_{k-1},i} \quad (12)$$

From this point, we now obtain a collection of nested models that will help us document further the admissible shapes of the bond market reaction function to macroeconomic announcements. This rather simple approach thus entitles us to build *LR* tests, as described in Davidson (1993). Models 1, 2 and 3 are nested, and likelihood ratio tests can be easily performed so as to chose which is the more interesting model, regarding the data at hand. These elements will be studied within the next section, along with the analysis of the results obtained with the models defined by equations (3), (6) and (9). In the remaining of the paper we refer to the model defined by equation (3) as model 1, to the one defined by equation (6) as model 2 and to the model defined by equation (9) as model 3. These notations are summarized in the following table :

Model	Equation #	Rates' dynamics
1	Equation (3)	$\Delta r_{t,i}(\tau) = \beta_{i,\tau} + \alpha_{i,\tau} S_{t,i} + \varepsilon_{t,i,\tau},$
2	Equation (6)	$\Delta r_{t,i} = \beta_i + \alpha_{1,i} 1_{\pi_{t,i} > \overline{\pi_{t,i}}} S_{t,i} + \alpha_{2,i} 1_{\pi_{t,i} \leq \overline{\pi_{t,i}}} S_{t,i} + \varepsilon_{t,i},$
3	Equation (9)	$\Delta r_{t_k,i} = \beta_i + \alpha_{1,i} 1_{\pi_{t,i} > \overline{\pi_{t,i}}} S_{t,i} + \alpha_{2,i} 1_{\pi_{t,i} \leq \overline{\pi_{t,i}}} S_{t,i} + \theta_i \varepsilon_{t_{k-1},i} +$

3 - Empirical results

In this Section, we systematically analyze the results of the estimations of the models presented in the previous section. First, we analyze the results obtained from the likelihood ratio tests performed over the different nested models, using the dataset presented earlier. From these estimation results, we propose a list of the most market mover figures for each maturity and we show that by using model 2 the list of market mover figures statistically increases. We also noticed that model 2 leads to intercepts that are statistically equal to 0, unlike model 1. Third, we propose to identify the shapes of the term structure response with those of the first four factors of a principal component analysis performed over the daily changes in the swap rates. By doing so, we show that there are several kinds of possible shapes for the hump-shaped term structure response to macroeconomic news (see e.g. Fleming and Remolona (2001)). Fourth, we propose a detailed analysis of the term structure response to several announcements, underlying the fact that the inclusion of a threshold variable reveals that model 1 often underestimates the true reaction function. We guess that this can either be due to the economic cycle dependence of the term structure effect or the existence of outliers within the dataset.

3. 1 Bulk effects of the introduction of the threshold variable

The introduction of those threshold variables produced remarkable effects on our estimations, yielding results that we believe are new. We present in tables 7, 8 and 9 the results of the estimation obtained from the models presented in the previous section. We only present the estimates of the model with the higher log-likelihood function, along with the following LR test. For example, let model 1 be the constrained model, with log likelihood denoted $\ln L_c$ and model 2 be the unconstrained model, with a log-likelihood denoted $\ln L_u$. The null hypothesis H_0 assumes that the constraint imposed in model 1 statistically holds. Thus, under H_0, model 1 is considered as a better model than the unconstrained model. Tables 7, 8 and 9 report the selected threshold variables along with the threshold value, that are estimated for each maturity and macroeconomic figures. We also report the LR test results, testing constrained against the unconstrained models. The test statistics is:

$$LR = 2(\ln L_c - \ln L_u) \quad (13)$$

with the previous notations. Under the null hypothesis that the constraint statistically holds, this statistic has a Chi-square distribution, with a degree of freedom equal to the number of constraints imposed in the constraint model. In our case, we have only one constraint, and the statistics is distributed as a χ_1^2, under the null. We proceed in a similar fashion to test model 3 vs. model 2.

The main result obtained with our methodology is that model 2 is globally the preferred model, regardless of the surprise and the maturity. When testing model 2 vs. model 1, the null is rejected at either a 5% or 10% risk level most of the time for every maturity. The few cases when it is not rejected are reported in table 3. This is an essential result for our work: model 2 provides a better explanation of the rates' behaviour than model 1. Even though model 1 is the one that is generally proposed in the literature, model 2 better encompasses an important feature of the rates' dynamic: the economic cycle dependence. Note that we do not report the LR test of model 3 against model 2, because the model 3 was almost always rejected at either a 5% or 10% level when compared to model 2.

The fact that the model 3 is always the model favoured in our estimation results cast some light on the way financial markets process the information depending on the current economic period. The different threshold variables are meant to measure the global stance of the economy, either on the inflation side or on the real activity side. The statistically significant change in the market reaction to these news depending on these threshold variables points toward a different way to process figures disclosure conditionally upon the information available in the economy. The main explanation for this fact is linked to the market's perception of monetary policy. After its decision meetings, the Central Bank is known to explain the level of the target rate with economic considerations. During periods of expansion or recession, the emphasize is not set on the same figures. The market reading of the information disclosure is thus led by the Central Bank speeches: this conclusion is thus in favour of a relative success in the Fed's communications.

The introduction of the state variables allowed us to point out more than the usual number of "market movers" figures: we consider that a market mover figure is an announcement for which the estimated impact in models 1 and 3 is statistically different from zero up to a 5% percent test. Here, almost every announcement that we tested was found to have a significant influence on the yield curve. Fleming and Remolona (2001) assumed that the use of daily data instead of intra day ones were to bring about an underestimation of the market reaction function. Here, we find that considering the market responses conditionally upon a threshold variable that has been properly selected puts an end to this underestimation. Almost every announcement produces an effect on the yield curve. In appendices, we propose two comparative tables to assess this point. In table 4, we present the ranked market mover announcements found when estimating model 1. In table 6, we report the ranked market mover announcements obtained when estimating model 2, along with the selected threshold variable and the threshold value. The main point about this table is that the number of market mover figures significantly increases when using model 2: the introduction of the threshold variable leads to the finding of a greater number of market mover figures. The exclusion of this threshold variable seems to bring about an underestimation of the term structure reaction to several announcements. In subsection 2.2.5.2., we detail some of the reasons explaining this new stylized fact.

One other remarkable fact about our methodology is the following: when estimating model 1, most of the intercepts are statistically different from zero up to a 5% risk level, unlike when estimating model 2. Table 5 reports figures and maturities for which this intercept remains statistically different from zero in model 2. The fact that this intercept can be statistically different from zero induces the idea of existing statistical arbitrages in the bond market. One may think of this constant term as an in the Capital Asset Pricing Model framework , as presented in Gourieroux and Jasiak (2001) and Campbell et al. (1997). Thus, when compared to model 2, model 1 is misspecified and leads to misleading ideas . This can be view as a very classic case of estimation bias due to the model misspecification.

Table 3: Announcements and maturities for which the null of the LR test is accepted, when testing model 2 vs. model 1.

Economic Announcement	Swap rates maturities
Household Consumption	1,6,7,9 and 10 year
Employment Cost Index	15,20 and 30 year
Empire Manufacturing Index	4,5,6,7,8,9,10,15,20 and 30 year
Personal Consumption	2,3,4,5 and 6 year

It is finally noteworthy to remark that beyond the regularities previously mentioned in the estimation results, it seems to be difficult to have a global rationale for the selection of the threshold variable. Expected findings can be noticed, such as the fact that the threshold variable for the "Wage" time series is the Fed's target rate -- which is rather natural since this figure is known to be closely monitored by market participants to predict the Fed's next gesture. However, for most of the figures, different threshold variables were selected, regardless of the nature of the figure itself. This should be linked to the very high correlation between the threshold variables time series: for example, PMI series and the Fed's target rate usually evolve closely. In this respect, the fact that different threshold variables are found to be linked to either real activity or inflation figures is not that surprising.

Table 4: List of the ranked market mover announcements found when using model 1.

Rank	2 year	5 year	10 year	30 year
1	Non Farm Payroll	Non Farm Payroll	Non Farm Payroll	Non Farm Payroll
2	ISM manuf	ISM manuf	ISM manuf	ISM manuf
3	Employment Cost Index	Employment Cost Index	Employment Cost Index	Employment Cost Index
4	Philifed Index	Philifed Index	Non Manuf. ISM	Non Manuf. ISM
5	Durable Good Orders	Personal Consumption	Indice Help Wanted	Indice Help Wanted
6	NAHB Housing Market Index	GDP after 1999	Industrial Production	Wholesale Inventory
7	Unemployment Rate	Non Manuf. ISM	Philifed Index	Philifed Index
8	Conf. Board Consumer Conf.	Retail Sales	GDP after 1999	New Home Sales
9	Jobless Claims	Industrial Production	Retail Sales	Retail Sales
10	Industrial Production	Conf. Board Consumer Conf.	Conf. Board Consumer Conf.	Industrial Production
11	Non Manuf. ISM	Jobless Claims	New Home Sales	Jobless Claims
12	New Home Sales	New Home Sales	Trade Balance	Chicago PMI
13	Chicago PMI	Durable Good Orders	Jobless Claims	
14		Chicago PMI	Chicago PMI	
15			Existing Home Sales	

Table 5 : Announcements for which the intercept is statistically different from zero both for model (1) and model (3)

Economic Announcement	Swap rates maturities
Household Consumption	3,4,6,7,8,9,10,15,30
Personal Income	2,3,4,6,7,8,9,10,15,30
ISM Manuf.	4,6,7,8,9,10,15,20,30
Existing Home Sales	8,9,15,20,30
Weekly Jobless Claims	1
Building Permits	1
Empire Manufacturing	1
Personal Consumption	1
Indice Help Wanted	1
NAHB Housing Index	1
Construction Spending	1,7,8,9,10,15,20,30

Table 6 : List of the ranked market movers figures found when estimating the threshold model for each available maturity.

	2 year		**5 year**		**10 year**	
Rank	**Variable**	**Condition**	**Variable**	**Condition**	**Variable**	**Condition**
1	Capacity Utilization Rate	FED<3,553	Capacity Utilization Rate	FED<3,553	Capacity Utilization Rate	FED<3,553
2	Trade Balance	PHI<-26,126	Philifed Index	PMI<41,189	Philifed Index	PMI<41,189
3	Philifed Index	PMI<41,189	Unemployment Rate	PMI>60,642	Unemployment Rate	PMI>60,642
4	Existing Home Sales	PMI<49,526	Consumer Price Index	CONF<78,937	ISM manuf	FED>6,211
5	Industrial New orders	PHI<-14,037	Non Farm Payroll	FACT1>97,784	Non Farm Payroll	FACT1>97,784
6	Consumer Price Index	CONF<78,937	Hourly Average Wages	FACT1>97,784	Consumer Price Index	CONF<78,937
7	Non Farm Payroll	FACT1>97,784	Building Permits	PMI<51,968	Hourly Average Wages	FACT1>97,784
8	Unemployment Rate	PMI>60,642	GDP after 1999	PMI<43,968	Building Permits	PMI<51,968
9	ISM manuf	FED>6,211	Industrial Production	PHI<-14,037	Conf. Board Consumer Conf.	PMI<43,968
10	Retail Sales	FED>6,211	Employment Cost Index	FED>5,342	Non Manuf. ISM	FACT1<64,883
11	Hourly Average Wages	FACT1>97,784	Wholesale Inventory	PHI<-10,226	Wholesale Inventory	PHI<-10,226
12	Industrial Production	PHI<-14,037	Non Manuf. ISM	FACT1<64,883	Retail Sales	CONF>122,779
13	Building Permits	PMI<51,968	Existing Home Sales	MICH<100,063	Existing Home Sales	MICH<100,063
14	Personal Consumption	MICH>96,011	Consumer Conf. Michigan	FACT1<61,227	New Home Sales	MICH>102,053
15	Non Manuf. ISM	PHI<-14,037	Personal Income	FACT1>94,128	Employment Cost Index	FED>5,342
16	Construction Spending	MICH<104,758	ISM manuf	MICH>86,137	Personal Income	FACT1>94,128
17	Employment Cost Index	FACT1>86,592	GDP	FACT1<85,497	Trade Balance	FACT2>-109,378
18	NAHB Housing Market Index	FACT2>-101,575	NAHB Housing Market Index	PHI>11,358	Weekly Jobless Claims	PHI<-5,616
19	Wholesale Inventory	PHI<-10,226	Conf. Board Consumer Conf.	PMI<49,526	Indice Help Wanted	FED<3,053
20	Weekly Working Hours	FACT2<-115,275	Trade Balance	FACT2>-112,93	Weekly Working	CONF>92,089

					Hours	
21	Conf. Board Consumer Conf.	FED>3,605	Weekly Working Hours	CONF>92,089	Personal Consumption	PMI>55,253
22	GDP	FACT1<85,497	Indice Help Wanted	FED<3,395	NAHB Housing Market Index	PHI>11,358
23	Productivity	PMI>58,589	Retail Sales	MICH>80,168	Industrial Production	PMI<56,474
24	Consumer Conf. Michigan	MICH>92,105	Personal Consumption	FACT1>71,872	Consumer Conf. Michigan	MICH>92,105
25	Empire Manufacturing	PMI<55,253	Chicago PMI	MICH<94,095	GDP after 1999	MICH>84,147
26	Indice Help Wanted	FED<3,395	New Home Sales	PMI>41,053	Chicago PMI	MICH<94,095
27	Chicago PMI	MICH<94,095	Wages	FACT1<65,128	Wages	FACT1<65,128
28	New Home Sales	PHI>-21,658	Weekly Jobless Claims	FACT1<81,692		
29	GDP after 1999	MICH<108,021	Construction Spending	PHI>1,868		
30	Weekly Jobless Claims	FACT1<81,692				
31	Construction Spending	PHI>1,868				

Table 7: Results of the estimation of the threshold model for the 2-year rate, using the best performing threshold variable. * is for 10% level and ** is for 5% level Student test confidence.

	2 year					
	Intercept	**>Th**	**<Th**	**Threshold**	**Th. value**	**LR test p-value**
Household consumption	0.008	0.004	-0.023	PMI	42.305	0.04
Personal Income	0,009*	0.004	-0.071	FACT1	61.227	0
ISM manuf	0,011**	0,119**	0,024**	FED	6.211	0
Industrial New orders	-0.001	0.001	0,235**	PHI	-14.037	0.01
Construction Spending	0	-0.021	0,057**	MICH	104.758	0.04
Consumer Credit	0.005	-0.567	-0.003	PHI	31.689	0
Wholesale Inventory	0.001	0.003	0,044**	PHI	-10.226	0.06
Retail Sales	-0.001	0,094**	0.007	FED	6.211	0.01
Industrial Production	-0.002	0.006	0,081**	PHI	-14.037	0
Housing Start	-0.001	0	-0.006	FACT1	68.538	0
Philifed Index	0.001	0,021**	0,59**	PMI	41.189	0
Existing Home Sales	0.006	0.001	0,36**	PMI	49.526	0.04
Conf. Board Consumer Conf.	-0.015	0,038**	0	FED	3.605	0
GDP	-0.001	-0.029	0,034**	FACT1	85.497	0
Chicago PMI	-0.023	0,004*	0,014**	MICH	94.095	0
New Home Sales	-0.011	0,01*	-0.41	PHI	-21.658	0
Consumer Price Index	-0.005	0.007	0,143**	CONF	78.937	0
Unemployment Rate	-0.003	0,128**	-0.022	PMI	60.642	0
Trade Balance	-0.002	0.008	1,077**	PHI	-26.126	0.01
Jobless Claims	0	-0.01	-0.094	PMI	41.189	0
Non Farm Payroll	0.003	0,133**	0,037**	FACT1	97.784	0
Capacity Utilization Rate	-0.008	0,013*	9,031**	FED	3.553	0
Employment Cost Index	-0.001	0,059**	-0.001	FACT1	86.592	0.01
Wages	-0.005	0.007	-0.002	FED	6.224	0.05
Productivity	-0.001	0,038*	-0.011	PMI	58.589	0.02
Durable Good Orders	0.004	-0.046	-0.001	FACT2	-111.393	0.01
Producer Price Index	-0.001	0.002	-0.027	PHI	-14.037	0
Hourly Average Wages	0.005	0,093**	-0.004	FACT1	97.784	0
Non Manuf. ISM	-0.006	0.005	0,067**	PHI	-14.037	0
Weekly Working Hours	0.001	-0.011	0,042**	FACT2	-115.275	0.01
Consumer Conf. Michigan	0.003	0,02**	-0.008	MICH	92.105	0.01

GDP after 1999	-0.009	-0.146	0,015*	MICH	108.021	0.01
Weekly Jobless Claims	0.002	0	0,012*	FACT1	81.692	0.1
Building Permits	-0.004	0.003	0,074**	PMI	51.968	0
Empire Manufacturing	0.011	-0.009	0,02**	PMI	55.253	0.09
Personal Consumption	-0.01	0,071*	0.008	MICH	96.011	0.11
Indice Help Wanted	0.004	-0.013	0,024**	FED	3.395	0.03
NAHB Housing Market Index	-0.001	0,052**	0.004	FACT2	-101.575	0.01
Construction Spending	0.006	0,017**	-0.048	PHI	1.868	0

Table 8 : Results of the estimation of the threshold model for the 5-year rate, using the best performing threshold variable. * is for 10% level and ** is for 5% level Student test confidence.

	5 year					
	Intercept	**>Th**	**<Th**	**Threshold**	**Th. value**	**LR test pvalue**
Household consumption	0.007	0.004	-0.017	PMI	48.568	0.08
Personal Income	0.007	0,042**	0	FACT1	94.128	0.02
ISM manuf	0.008	0,049**	0	MICH	86.137	0
Industrial New orders	-0.001	0.003	-0.106	CONF	78.937	0.01
Construction Spending	0.004	0.015	-0.18	FACT1	68.668	0.01
Consumer Credit	0.003	-0.589	-0.001	PHI	31.689	0
Wholesale Inventory	0	0.004	0,061**	PHI	-10.226	0.02
Retail Sales	0.003	0,025**	-0.021	MICH	80.168	0.03
Industrial Production	-0.004	0.009	0,071**	PHI	-14.037	0
Housing Start	-0.005	0	-0.004	PHI	-6.416	0
Philifed Index	0.003	0,02**	0,587**	PMI	41.189	0
Existing Home Sales	0.006	0.001	0,051**	MICH	100.063	0.01
Conf. Board Consumer Conf.	-0.006	-0.003	0,039**	PMI	49.526	0
GDP	-0.001	-0.025	0,04**	FACT1	85.497	0
Chicago PMI	-0.025	0,004*	0,014**	MICH	94.095	0.01
New Home Sales	-0.006	0,013**	-0.36	PMI	41.053	0.01
Consumer Price Index	-0.005	0.008	0,142**	CONF	78.937	0.01
Unemployment Rate	0.004	0,152**	-0.016	PMI	60.642	0
Trade Balance	-0.004	0,036**	0	FACT2	-112.93	0.01
Jobless Claims	0	-0.01	-0.087	PMI	41.189	0
Non Farm Payroll	0.008	0,149**	0,033**	FACT1	97.784	0
Capacity Utilization Rate	-0.011	0,013*	7,28**	FED	3.553	0
Employment Cost Index	0.002	0,073**	0.015	FED	5.342	0
Wages	-0.009	-0.002	0,012**	FACT1	65.128	0.01
Productivity	-0.007	0.036	-0.009	PMI	58.589	0.07
Durable Good Orders	-0.004	-0.199	-0.01	PMI	64.811	0.01

Producer Price Index	-0.007	0.001	-0.025	PHI	-14.037	0.01
Hourly Average Wages	0.01	0,108**	-0.003	FACT1	97.784	0
Non Manuf. ISM	0.001	0.006	0,063**	FACT1	64.883	0
Weekly Working Hours	0.002	0,038**	-0.029	CONF	92.089	0
Consumer Conf. Michigan	-0.002	0.003	0,05**	FACT1	61.227	0.01
GDP after 1999	-0.01	0,015*	0,088**	PMI	43.968	0.04
Weekly Jobless Claims	0.001	0	0,017**	FACT1	81.692	0.04
Building Permits	-0.009	-0.001	0,103**	PMI	51.968	0
Empire Manufacturing	0.019	0.009	-0.09	MICH	75.758	0.37
Personal Consumption	-0.006	0,024**	-0.044	FACT1	71.872	0.16
Indice Help Wanted	0.01	-0.018	0,033**	FED	3.395	0.01
NAHB Housing Market Index	-0.01	0,042**	-0.019	PHI	11.358	0
Construction Spending	0.013	0,018**	-0.051	PHI	1.868	0

Table 9 : Results of the estimation of the threshold model for the 10-year rate, using the best performing threshold variable. * is for 10% level and ** is for 5% level Student test confidence.

	10 year					
	Intercept	**>Th**	**<Th**	**Threshold**	**Th. value**	**LR test pvalue**
Household consumption	0,012**	-0.022	0.002	FED	4.763	0.11
Personal Income	0,009*	0,041**	-0.001	FACT1	94.128	0.01
ISM manuf	0,018**	0,122**	0,027**	FED	6.211	0
Industrial New orders	-0.002	0.006	-0.102	CONF	78.937	0.01
Construction Spending	0.005	0.018	-0.15	FACT1	68.668	0.01
Consumer Credit	0	-0.459	-0.002	PHI	31.689	0
Wholesale Inventory	0.002	0	0,059**	PHI	-10.226	0.02
Retail Sales	0	0,05**	0.008	CONF	122.779	0.03
Industrial Production	-0.011	-0.008	0,027**	PMI	56.474	0.02
Housing Start	-0.009	0	-0.005	CONF	78.937	0.01
Philifed Index	-0.004	0,015**	0,568**	PMI	41.189	0

Existing Home Sales	0.005	0,001*	0,052**	MICH	100.063	0.01
Conf. Board Consumer Conf.	-0.005	0.006	0,065**	PMI	43.968	0
GDP	-0.018	-0.029	0.025	FACT1	85.497	0.01
Chicago PMI	-0.027	0,004*	0,012**	MICH	94.095	0.03
New Home Sales	-0.009	0,053**	0.008	MICH	102.053	0.01
Consumer Price Index	-0.011	0.008	0,118**	CONF	78.937	0.02
Unemployment Rate	0.001	0,138**	-0.014	PMI	60.642	0
Trade Balance	-0.01	0,043**	0.001	FACT2	-109.378	0
Jobless Claims	-0.003	-0.007	-0.08	PMI	41.189	0
Non Farm Payroll	0.003	0,128**	0,024**	FACT1	97.784	0
Capacity Utilization Rate	-0.018	0.011	5,238**	FED	3.553	0
Employment Cost Index	-0.004	0,058**	0.013	FED	5.342	0.03
Wages	-0.013	-0.001	0,013**	FACT1	65.128	0.01
Productivity	-0.007	-0.004	-0.088	PHI	-14.037	0.04
Durable Good Orders	-0.004	-0.009	-0.551	PHI	-25.984	0
Producer Price Index	-0.009	0	-0.017	PHI	-14.037	0.07
Hourly Average Wages	0.007	0,09**	-0.001	FACT1	97.784	0
Non Manuf. ISM	0.001	0.008	0,061**	FACT1	64.883	0
Weekly Working Hours	0.001	0,034**	-0.025	CONF	92.089	0.01
Consumer Conf. Michigan	0.003	0,022**	-0.008	MICH	92.105	0.01
GDP after 1999	-0.008	0,02**	-0.039	MICH	84.147	0.07
Weekly Jobless Claims	-0.001	0.001	0,042**	PHI	-5.616	0.02
Building Permits	-0.012	-0.002	0,091**	PMI	51.968	0
Empire Manufacturing	0.002	-0.023	0.011	PHI	33.216	0.39
Personal Consumption	0.002	0,033**	-0.013	PMI	55.253	0.05
Indice Help Wanted	0.01	-0.017	0,04**	FED	3.053	0
NAHB Housing Market Index	-0.015	0,032**	-0.009	PHI	11.358	0.02
Construction Spending	0,017**	0.011	-0.048	PHI	1.868	0

3. 2 Term structure identification

We propose to move a step further toward the analysis of our results. When reading tables 7, 8 and 9, one can clearly see that most of the shapes of the term structure responses to macroeconomic news are hump-shaped, as already noted by Fleming and Remolona (2001). But even though most of them present this kind of shape, while analysing the results, we found different forms of these term structure responses. What is more, these shapes surprisingly match those of the correlation between swap rates across maturities and the first four factors of a principal component analysis (PCA hereafter) performed over the daily changes in the swap rates. Since Litterman and Scheinkman (1991), using PCA to assess the shape of the factors that are actually moving the yield curve is very classic. The method is still used for the analysis of bond market factors (see e.g. Lardic and Priaulet (2003)). On this preliminary remark, we propose a methodology to build a classification of the term structure responses of the swap rates to macroeconomic announcement using these four factors.

Using the dataset presented in Section 2, we performed a principal component analysis over the daily changes in the swap rates, with maturities ranging from 1- to 30-year. Figure 1 presents the correlations between the first four factors of the PCA and the one-day changes in the swap rate across maturities. Let us denote $F_{t,k}$ the value of the k^{th} factor on date t and $\Delta r_t(\tau)$ the change in the swap rate of maturity τ on the same date. For the time being, these notations are independent of the surprises. Then, let us denote $\rho_{k,\tau}$ the correlation:

$$\rho_{k,\tau} = cor(F_k, \Delta r(\tau)) \qquad (14)$$

where $cor(.)$ is the correlation coefficient. We decided to consider[7] factors 1 to 4, using the classical elbow method to select the number of eigenvalues and eigenvectors to retain for this PCA. This method is used to select the usual number of factors to retain to perform a PCA analysis: it uses the decreasing pace of the eigenvalues of the rates' correlation matrix as an

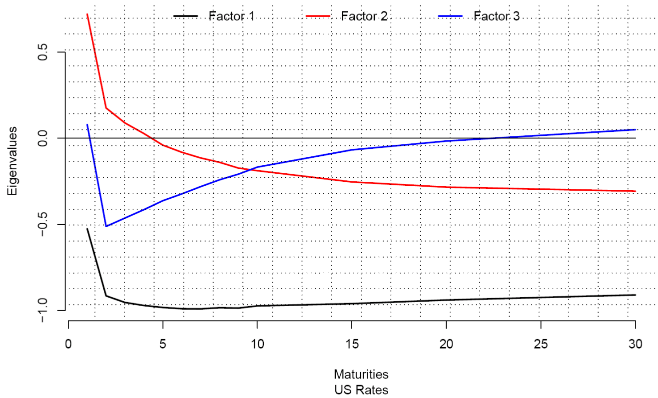
[7] Most of the studies achieved so far concluded with the fact that three factors were actually driving the pure discount bond yield curve. To our mind, one key explanation for this divergence with the classical literature is due to the fact we use a very recent dataset.

indicator to decide which factors to cut. In our case, the inflection point were found for a number of factors equal to 4. This is a standard way to proceed in the literature: again, see the seminal paper of Litterman and Scheinkman (1991).

By studying the $\rho_{k,\tau}$, we are able to discuss the impact of the factor k on the yield curve. Figure 1 presents the correlations between each factor and the jumps in swap rates for a given maturity. Clearly, these factors do not seem to have the same impact on the yield curve. Factor 1 is considered as a level factor and is often related to the monetary policy stance (see e.g. Bomfim (2003), Wu (2001) and Ang et a. (2005)). Factor 2 is extremely well positively correlated (close to one) with the changes in one-year swap rates and thus governs the slope of the beginning of the yield curve. Factor 3 is highly correlated to the swap rates of maturities 2 to 7 years and thus drives the concavity of the curve. Finally, the fourth factor is well correlated to maturities a bit longer than factor 3, that is maturities from 6 till 9 years, and is thus again a concavity factor. These results can also be found in other articles such as Steeley (1990), Litterman and Scheinkman (1991), Knez et al. (1994) and more recently Molgedey and Galic (2000) and Blaskowitz et al. (2005).

In this respect, our analysis identifies four types of factors: a first type that seems to be hump-shaped and should be theoretically driven by the conduct of monetary policy; a second type affecting mainly the short rate positively; a third type affecting negatively maturities for 2 to 7 years and a fourth one affecting negatively maturities from 6 to 9 years.

Figure 1: Correlations between factors 1 to 4 and the jumps in rates for maturities till 30 years



Noting that the shapes of the impact of the surprises on the yield curve are graphically close to the shapes of the correlations $\rho_{k,\tau}$ across maturities, we propose an identification process to be able to match the effect of the announcements to the factors of the PCA. We propose the following method. Let $\alpha_{i,\tau}$ be the estimate of the impact of the announcement i on the change in swap rate for a maturity τ. Thus, we have:

$$\Delta r_{t,i}(\tau_h) = \beta_{i,\tau} + \alpha_{i,\tau} S_{t,i} + \varepsilon_{t,i,\tau} \qquad (15)$$

under the assumptions 2.2. Now, for a given announcement i, we propose to compare $\rho_{k,\tau}$ and $\alpha_{i,\tau}$ across maturities , for each factor k. Note that the $\alpha_{i,\tau}$ can either be estimated with model 1, 2 or 3: we present the methodology using model 1 as an example for the sake of notational simplicity. From now on, we propose to state that an announcement i produces a factor k-like effect on the yield curve when the distance between $\rho_{k,\tau}$ and $\alpha_{i,\tau}$ is the lowest across maturities τ and among the different possible factors. For this purpose, we propose to estimate the following linear model for each factor k and for a given announcement i:

$$\alpha_{i,\tau} = \gamma_0 + \gamma_1 \rho_{k,\tau} + \nu_{k,\tau}, \forall \tau, \qquad (16)$$

and retain the estimated variance of $\nu_{k,\tau}$ as a distance measure between $\alpha_{i,\tau}$ and $\rho_{k,\tau}$. In equation (16), γ_0 and γ_1 are real-valued parameters estimated by OLS. ν_k a Gaussian white noise, with variance σ_k^2. Now, for example, if σ_1^2 is inferior to σ_2^2, σ_3^2 and σ_4^2 for a given surprise i, then we say that this surprise produce a factor 1-like effect on the yield curve.

In table 10, we report the results of the latter method, using the estimation results obtained with model 2. Tables 11 and 12 provide empirical frequencies regarding the number of announcements per yield curve factor. Most of the announcements seem to match the factor 1 of the yield curve, but we found many other announcements matching the remaining factors. We believe that the results presented here are new, along with the idea that there are several types of shapes for the term structure announcements.

Table 10: Results of the estimation of the model defined by equation (16) and identification of the factors of the yield curve (1)

Indicator	Condition	Pattern
Household Consumption	PMI<48	Factor 4
Personal Income	FACT>94	Factor 1
Personal Income	FED<3,25	Factor 1
ISM manuf	PMI<60	Factor 1
Industrial New orders	PMI<42	Factor 1
Construction Spending	FACT1<69	Factor 4
Construction Spending	PHI<-5	Factor 1
Consumer Credit	MICH>94	Factor 1
Wholesale Inventory	PMI<50	Factor 2
Retail Sales	MICH>80	Factor 2
Industrial Production	PMI<50	Factor 2
Housing Start	FACT1<68	Factor 1
Philifed Index	PMI>42	Factor 1
Existing Home Sales	PMI>50	Factor 4
Conf. Board Consumer Conf.	FED>3,5	Factor 2
GDP	FACT1<85	Factor 1
GDP	PMI<51	Factor 3

GDP	PMI>51	Factor 1
GDP	FACT1<85	Factor 1
Chicago PMI	MICH>95	Factor 4
Chicago PMI	MICH<95	Factor 1
New Home Sales	PMI<60	Factor 1
Unemployment Rate	PMI<60	Factor 1
Consumer Price Index	MICH>98	Factor 1
Trade Balance	PMI>50	Factor 1

Now, an in depth analysis of the estimation tables yield two different findings: first, each announcement can have a different term effect on the term structure of the interest rates. While reading the estimation tables, what can be clearly noted is that most of the figures lead to a hump-shaped reaction function (a factor 1-like effect). Once the PCA is performed, this result should not surprise anyone: the first factor, that is the hump shaped one, is supposed to explain more than eighty percent of the total variance of the overnight change in swap rates sample at hand. Nevertheless, this kind of shape is not the only one that the results pointed out: we found three other shapes that clearly match that of the three remaining factors extracted using PCA. One supporting fact of our findings is that the empirical frequencies associated to this classification are quickly decaying, just like when analyzing the eigenvalues obtained when performing a PCA over the rates. We believe that this fact is new. Second, we found that when modifying the threshold variable and the threshold value, a similar announcement can have different effects on the yield curve, depending upon the state of the US economy for example. A careful reading of tables 11 and 12 should provide important results both to academics and practitioners. We will document this point in the next subsection with well chosen examples.

4 - Selected announcements and the underestimation problem

In this subsection, we detail with a greater attention some of the results we thought of interest, regarding the economic cycle dependence and the effects of the outliers on the estimations.

4. 1 The economic cycle effect

We found several types of statistical effects linked to the introduction of the threshold variables that we thought of equal importance. As we initially used these variables for, we came to be able to separate the bond market reaction function to announcements during expansion and recession cycles. Three types of results arose: first, some announcements were found to have a sharper effect on the yield curve during either the recession or the expansion period, matching in both these cases the same factor pattern. Second, some announcements seemed to have an effect during only one of those periods, and no effect during the other one. Third, a few announcements were found to have a different type of effect on the yield curve, depending upon the threshold variable. In such a case, the global stance of the economy not only influences the strength of the market response to some surprises: it also brings about a change in the type of term structure of the rates' response to surprises. We propose hereafter some examples of these statistical effects that we found within our estimations.

First, some of the figures were found to have a sharper effect on the changes in US swap rates when the threshold variable lies below or above the estimated threshold. What is more, the average effect of the announcement usually under- or over-estimates the actual term structure of the swap rates' response. The announcement of Non-farm Payroll is a good example of such a pattern. As presented in figure 2, the average effect (i.e. estimated with model 1) of the announcement lies typically below (above) the one obtained when considering the sample for which the threshold variable lies above (below) the estimated threshold. This has important implications for the building of interest rates models, both for professionals of finance and for monetary policy makers: the Non Farm Payroll (NFPR hereafter) figure is not that closely monitored by financial markets during slowdown periods, but is of tremendous importance during expansion ones. What is more, the term structure reaction matches factor 1 for both cases, suggesting that this variable is interpreted by financial markets as monetary policy driving figure.

Second, for some figures, only one period includes a statistically different from zero term structure reaction of the US swap rate. The average effect (estimated with model 1) cam statistically be set to zero and only one of the two states associated to model 3 yields non-zero estimates. The Capacity Utilization Rate is an example of this phenomenon: when the Fed's target rate is above 3.5\%, the term structure effect is globally equal to zero. On the contrary, when the target rate is below 3.5\%, one gets an important hump-shaped reaction function. This effect is presented in figure 3. Again, this has important implications for the understanding of the reaction of interest rates to macroeconomic announcements. What is more, this type of effect could explain the fact that high-frequency dataset led to the finding of more market mover figures than the daily ones.

Figure 2: Swap rates reaction function to a positive surprise for Non Farm Payroll (plain line) and 95\% confidence intervals (dotted lines).

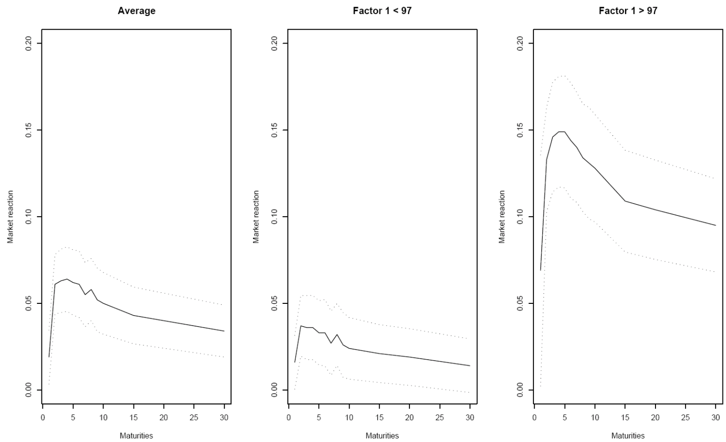
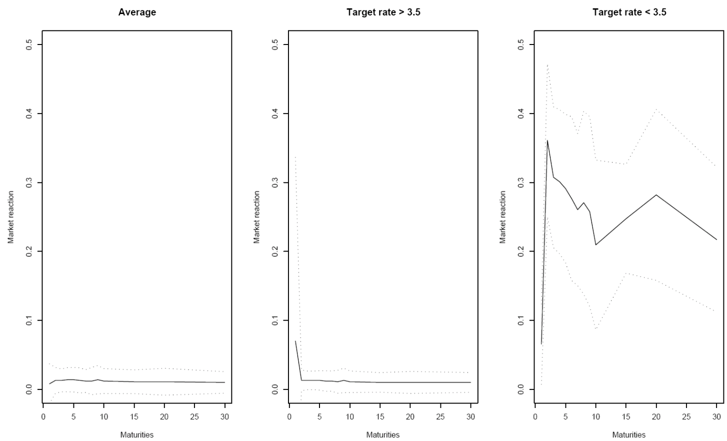
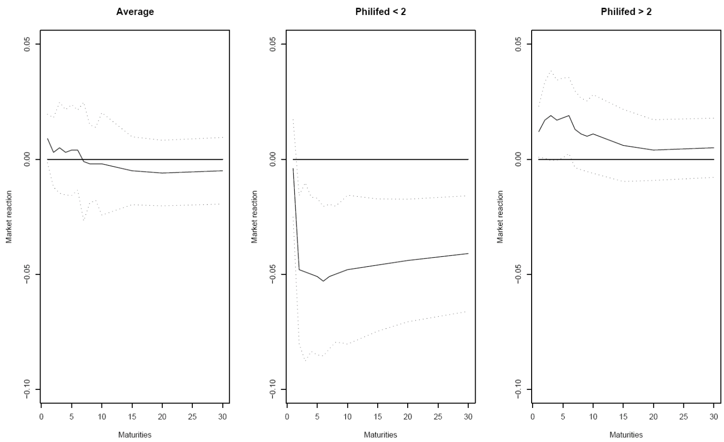


Figure 3 : Swap rates reaction function to a positive surprise for Capacity Utilization Rate (plain line) and 95\% confidence intervals (dotted lines).



Finally, the most striking effect is for figures that lead to different types of shapes of the term structure responses, depending upon the level of the threshold variable. Until now, we simply underlined figures for which we found the same term structure effect across the different values of the threshold variable. But for some figures, the term structure effect seems to depend on the state of the economy. This means that the interpretation of the signal driven by these variables is state-dependent. One example of such pattern is the Construction Spending figure. Figure 4 presents the different patterns of the term structure reaction of the swap rates to positive surprises, depending on whether the Philifed index is above or below 2. Philifed Index is a sentiment survey. Depending upon the threshold variable, we obtain two different patterns: a positive reaction function that is close to the factor 3 shape when the Philifed is above 2 and a negative hump-shaped one that is close to the factor 1 pattern when the Philifed is below 2. This means that the market perception of construction spending strongly depends on the state of the economy.

Figure 4 : Swap rates reaction function to a positive surprise for Construction Spending (plain line) and 95\% confidence intervals (dotted lines).



4. 2 The outliers effect

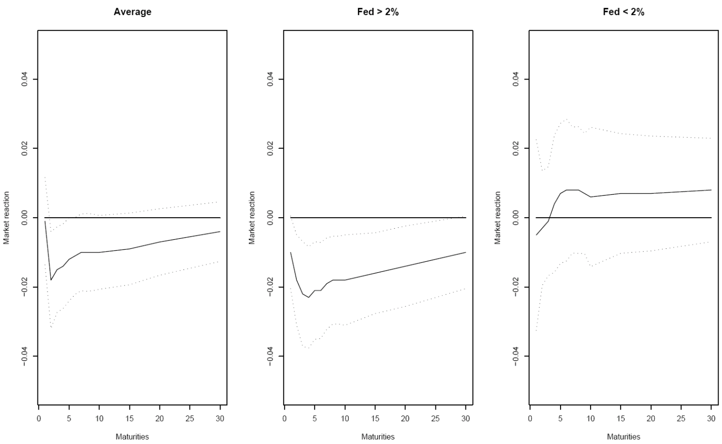
Some recent papers using high frequency datasets (e.g. Fleming and Remolona (2001)) found a greater number of market mover figures than usually found in daily datasets. Our estimations results produced one possible explanation for this phenomenon. The existence of outliers within the changes in the swap rates across maturities leads to biased estimations of the term structure reaction. This is in line with what has been said in the previous section: the sample splitting produced by the introduction of a threshold variable led to the assessment of an over- or under-estimation of the bond market reaction function. This phenomenon is often referred to as aliasing, and is well known and diagnosed using jump models (see e.g. Andersen et al. (2003)).

These outliers generally appear when the global economic stance of the US is very high or very low, that is to say close to turning points in the economy. Bond markets seem to have odd reactions when getting near these turning points. In fact, one can assume that during these periods, the expectations of bond market participant are very sensitive to any breaking news in the economy. Turning points in the economy are very important in so far as they match the inversion of the central bank policy. When the Fed comes to the end of a tightening cycle, the turning point will trigger the beginning of an easing cycle of the monetary policy and a progressive reduction of the target rate. In this perspective, the forward rates, and thus the spot rates are very sensitive to these changes in economic perspectives.

The estimation results presented in tables 7, 8 and 9 point toward the fact that getting rid of these outliers brings about a reduction of the estimation bias in the bond markets' term structure reaction function. Here again, we found three types of effects: a first one for which we observed an underestimation of the rates' reaction function to macroeconomic announcements, when the effect of the announcement were already considered significant for model 1; a second one that is related to announcements for which the response is primarily found to be statistically zero when the outliers are maintained in the dataset, and different from zero if not; a third one, for which, in case of extreme economic situation, the market reaction function is statistically non zero.

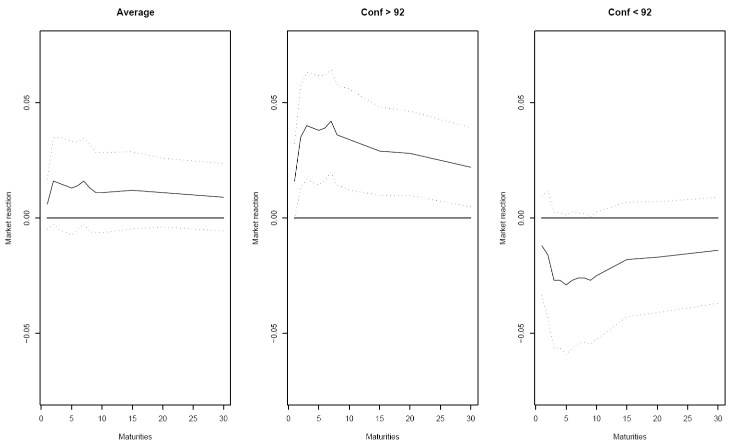
First, when the sample splitting leads to the elimination of a few outliers, the estimated term structure reaction function may be more important for the sample that excludes the outliers. This is for example the case of the Durable Good Orders and of the Philifed Index. When estimating the swap rate reaction function to such announcements with model 1, one would find significant estimates. Nevertheless, the estimates obtained in the threshold model are more significant and present a superior absolute value, when the selected threshold variable is above or below the estimated threshold value. Figure 5 presents the term structure reaction to the announcement of the Durable Good Orders, when the Fed fund target rate is below or above 2%.

Figure 5 : Swap rates reaction function to a positive surprise for Durable Goods Orders (plain line) and 95% confidence intervals (dotted lines).



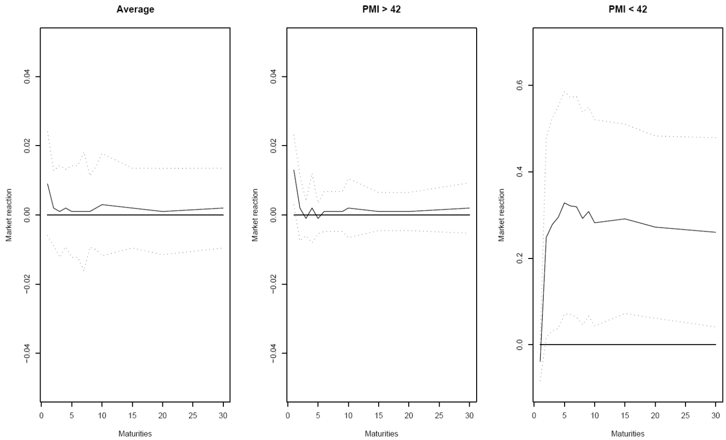
Secondly, the estimation of the impact of some of the studied figures leads to the finding of no remarkable effect on the yield curve when using model 1. The exclusion of the outliers from the dataset then brings about very different estimation results, suggesting that the first estimates were biased because of the presence of these extreme values. Good examples of this fact are the Unemployment Rate and the Weekly Working Hours. Without the sample splitting process, one would conclude with the fact that these announcements do not have any effect on swap rates. When implementing our methodology, we find that the shape and the significance of the term structure's reaction function of the swap rates is clearly very different. In figure 6 we present the term structure of the announcement effect of the Weekly Working Hours on the swap rates curve, documenting what has just been said.

Figure 6 : Swap rates reaction function to a positive surprise for Weekly Working Hours (plain line) and 95\% confidence intervals (dotted lines).



Finally, a last type of effects appeared in the estimation results: some of the studied figures produce no significant effect on the yield curve when estimating model 1, but during very special occasions can have a dramatic impact across maturities. For a few outliers, the response of the swap rates is again important and hump-shaped. The Industrial Orders figure is a good example of such a pattern: the model presented in Section 2 that maximized the log-likelihood was the one using the PMI (Purchasing Manager Index) as a threshold variable. When the PMI index is below 42, which is rarely the case, the term structure of the rates' reaction is significant for each maturity. On the contrary, when the PMI is above 42, we did not find any observable effect. This is presented in figure 7. One should remain cautious regarding the interpretation of this finding. The few observations for this type of event makes it hard to be very conclusive. Nevertheless, the fact we have again a hump-shaped reaction function tends to support the idea that industrial orders are a closely-watched figure in financial markets when getting closer to the end of the slowdown cycle of the economy.

Figure 7 : Swap rates reaction function to a positive surprise for Industrial Orders (plain line) and 95\% confidence intervals (dotted lines).



5 - Conclusion

The aim of this article was to estimate a collection of nested time series models for data-mining purposes. We found several new results. First, the use of a threshold model for the analysis of the term structure effect of macroeconomic announcements yields a much longer list of market mover figures. Second, we found that the classical hump-shaped term structure reaction function of interest rates to market mover announcements was not the only existing shape. At least three to four shapes may have to be considered, surprisingly matching that of the first four factors of a PCA performed over the daily changes in the shape rates. We develop a distance measure to build a classification of the term structure effect of announcements on the yield curve. Third, we found that the introduction of a state variable often leads to a better understanding of the reaction function to most of the announcements. When the economy is slowing or roaring, the impact of the surprises in the announcements is obviously not the same. It can even change the shape of the term structure reaction itself. Fourth, the sample splitting used throughout the paper makes it possible to isolate a few outliers and to analyze the rates' dynamic on each sample separately. The results point toward the fact that these outliers often bring about an underestimation of the reaction function.

Table 11: Results of the estimation of the model defined by equation (16) and identification of the factors of the yield curve (2)

Indicator	Condition	Pattern
Jobless Claims	PMI>40	Factor 1
Non Farm Payroll	FACT1>97	Factor 1
Non Farm Payroll	FACT1<97	Factor 1
Capacity Utilization Rate	FED<3,5	Factor 1
Employment Cost Index	CONF>110	Factor 1
Wages	PMI>48	Factor 2
Durable Good Orders	FED>2	Factor 1
Durable Good Orders	PMI>52	Factor 3
Durable Good Orders	PMI<52	Factor 3
Producer Price Index	FED>3,25	Factor 2
Hourly Average Wages	PMI>50	Factor 3
Import Price Index	PMI>50	Factor 3
Non Manuf. ISM	PMI<60	Factor 2
Weekly Working Hours	CONF>92	Factor 1
Consumer Conf. Michigan	CONF>110	Factor 1
GDP after 1999	CONF<130	Factor 2
GDP after 1999	CONF>105	Factor 2
Weekly Jobless Claims	PMI<57	Factor 2
Building Permits	PMI<50	Factor 1
Empire Manufacturing	PMI<55	Factor 1
Personal Consumption (Q)	PMI>55	Factor 4
Indice Help Wanted	PMI<51	Factor 1
NAHB Housing Market Index	PHI>11	Factor 1
Construction Spending	PHI<2	Factor 1
Construction Spending	PMI<54	Factor 2
Construction Spending	PHI>2	Factor 3

Table 12: Number of announcements matching one of the factors of the yield curve found during the estimation process.

	Factor 1	Factor 2	Factor 3	Factor 4
Number	29	11	6	5
Total number	51	51	51	51
Empirical frequency	56.9%	21.6%	11.8%	9.8%

References

Andersen, T. G., Bollerslev, T., and Diebold, F. X. (2003). Some like it smooth, and some like it rough: Untangling continuous and jump components in measuring, modelling, and forecasting asset return volatility. *CFS Working Paper Series 2003/35, Center for Financial Studies*.

Ang, A., Dong, S., and Piazzesi, M. (2005). No-Arbitrage Taylor Rules. *Working Paper, Columbia University*.

Ang, A. and Piazzesi, M. (2003). A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables. *Journal of Monetary Economics*, 50(4), 745-87.

Balduzzi, P., Elton, E. J., and Green, T. C. (2001). Economic News and the Yield Curve: Evidence from the U.S. Treasury Market. *Journal of Financial and Quantitative Analysis*, 36(4),523-543.

Baumohl, B. (2005). The Secrets of Economic Indicators. *Wharton School Publishing, University of Pennsylvania, USA*.

Bernanke, B. S. and Boivin, J. (2001). Monetary Policy in a Data-Rich Environment. *NBER Working Papers 8379, National Bureau of Economic Research, Inc.*

Blaskowitz, O., Herwartz, H., and de Cadenas Santiago, G. (2005). Modelling the FIBOR/EURIBOR Swap Term Structure: An Empirical Approach. *SFB 649 Discussion Papers SFB649DP2005-024, Sonderforschungsbereich 649, Humboldt University, Berlin, Germany*.

Bomfim, A. N. (2003). Monetary policy and the yield curve. *Finance and Economics Discussion Series 2003-15, Board of Governors of the Federal Reserve System (U.S.).*

Brière, M. (2006). Market Reactions to Central Bank Communication Policies: Reading Interest Rate Options Smiles. *Solvay Business School WP-CEB, 06-009.*

Brière, M. and Ielpo, F. (2008). Yield Curve Reaction to Macroeconomic News in Europe: Disentangling the US influence. in Stavarek, Daniel and Stanislav Poloucek (eds). 2008. *Consequences of the European Monetary Integration on Financial Markets. Newcastle: Cambridge Scholars Publishing.*

Campbell, J., Lo, A., and MacKinlay, C. (1997). The Econometrics of Financial Markets. *Princeton University Press, New Jersey.*

Campbell, J. and Shiller, R. (1991). Yield Spreads and Interest Rate Movements: A Bird's Eye View. The Review of Economic Studies.

Special Issue: The Econometrics of Financial Markets, 58(3), 495-514.

Chan, K. S. (1990). Testing for Threshold Autoregression. *Ann. Statist.*, 4, 1886-1894.

Davidson, R. and MacKinnon, J. G. (1993). Estimation and Inference in Econometrics. *Oxford University Press.*

Dufrénot, G., Mignon, V., and Péguin-Freissolle, A. (2004). Business Cycles Asymmetry and Monetary Policy: A Further Investigation Using MRSTAR Models. *Economic Modelling, 21(1), 37-71.*

Edison, H. J. (1996). The reaction of exchange rates and interest rates to news releases. *International Finance Discussion Papers 570, Board of Governors of the Federal Reserve System (U.S.).*

Fleming, M. J. and Remolona, E. M. (1997). What moves the bond market? *Research Paper 9706, Federal Reserve Bank of New York.*

Fleming, M. J. and Remolona, E. M. (2001). The Term Structure of Announcement Effects. *Staff Reports 76, Federal Reserve Bank of New York.*

Gourieroux, C. and Jasiak, J. (2001). Econometrics of Finance. *Princeton University.*

Greene, W. (2000). Econometric Analysis. *Prentice-Hall International.*

Grossman, J. (1981). The 'Rationality' of Money Supply Expectations and the Short-Run Response of Interest Rates to Monetary Surprises. *Journal of Money, Credit and Banking*, 13, 409-424.

Hans, D. (2001). Surprises in U.S. Macroeconomic Releases: Determinants of Their Relative Impact on T-Bond Futures. *Center of Finance and Econometrics, University of Konstanz, (Discussion Paper No. 2001/01).*

Hansen, B. E. (1997). Inference in tar models. *Studies in Nonlinear Dynamics and Econometrics,* 2, 1-14.

Hansen, B. E. (2000). Sample splitting and threshold estimation. *Econometrica*, 68(3), 575-604.

Hardouvelis, G. (1988). Economic News, Exchange Rates and Interest Rates. *Journal of International Money and Finance*, 7, 23-35.

Jarrow, R. A. (2002). Modelling Fixed Income Securities and Interest Rate Options. *Mc Graw Hill.*

Kishor, N. and Koenig, E. (2005). VAR Estimation and Forecasting when Data Are Subject to Revision. *Working Papers 05-01, Federal Reserve Bank of Dallas.*

Knez, P. J., Litterman, R., and Scheinkman, J. A. (1994). Explorations into factors explaining money market returns. *Journal of Finance,* 49(5), 1861-82.

Lardic, S. and Mignon, V. (2003). Analyse Intraquotidienne de l'Impact des "News" sur le March□e Boursier Français. *Economie Appliquée*, LVI(2), 205-237.

Lardic, S. and Priaulet, P. (2003). Answers about PCA Methodology on the Yield Curve. *Journal of Bond and Management Trading*, 4, 327-349.

Lim, K. and Tong, H. (1980). Threshold Autoregression, Limit Cycles and Cyclical Data. *J. Roy. Statist. Soc*., 42, 245-292.

Lintner, J. (1965). Valuation of Risky Assets and the Selection of Risky Investments in Stock Portfolio and Capital Budgets. *Review of Economics and Statistics*, 47, 13-37.

Litterman, R. and Scheinkman, J. (1991). Common Factors a Affecting Bond Returns. *Journal of Fixed Income*, 1, 54-61.

Martellini, L., Priaulet, P., and Priaulet, S. (2003). Fixed Income Securities : Valuation, Risk Management and Portfolio Strategies. *Wiley*.

Molgedey, L. and Galic, E. (2000). Extracting Factors for Interest Rate Scenarios. The European Physical Journal, B20, 517-522.

Mossin, J. (1966). Equilibrium in Capital Asset Market. *Econometrica*, 35, 768-783.

Orphanides, A. (2001). Monetary Policy Rules Based on Real-Time Data. *American Economic Review*, 91(4), 964-985.

Prag, J. (1994). The Response of Interest Rates to Unemployment Rate Announcements: Is there a Natural Rate of Unemployment. *Journal of Macroeconomics*, 16, 171-184.

Sharpe, W. (1964). Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk. *Journal of Finance*, 84, 425-442.

Steeley, J. (1990). Modelling the Dynamics of the Term Structure of Interest Rates. *Economic and Social Review, Symposium on Finance*, 21(4), 337-361.

Stock, J. and Watson, M. (2002). Macroeconomic Forecasting using Diffusion Indexes. *Journal of Business and Economic Statistics*, 20(2), 147-162.

Taylor, J. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy*, 39(1), 195-214.

Tong, H. (1990). Non-linear Time Series: A Dynamical System Approach. *Oxford University Press, Oxford, UK*.

Urich, T. and Watchel, P. (1981). Market Response to the Weekly Money Supply Announcements in the 1970's. *Journal of Finance*, 36, 1063-1072.

Veredas, D. (2005). Macroeconomic Surprises and Short Term Behaviour in Bond Futures. *Empirical Economics*, 30, 791-794.

Wu, T. (2001). Monetary policy and the slope factor in empirical term structure estimations. *Working Papers in Applied Economic Theory 2002-07, Federal Reserve Bank of San Francisco.*